Landbird Monitoring Protocol for Klamath Network Parks

Standard Operating Procedure (SOP) #17: Data Analysis and Reporting

Version 1.0

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP provides details of the analyses and reporting elements of the monitoring plan to ensure that the data and results of the landbird monitoring program are consistent with the landbird monitoring objectives and are available to the KLMN parks, the scientific community, and the public. These include two reporting elements: (1) an annual effort report and (2) third year analysis and synthesis reports. These reports are intended to address the objectives of the KLMN landbird monitoring efforts and to inform the KLMN program's annual reporting and 5-year synthesis reporting processes.

Data analysis and reporting will be conducted to meet the primary landbird monitoring objectives:

1. Monitor breeding landbird richness, relative abundance, and density.
   - Determine the status of breeding landbird richness and relative abundance every 3 years within the sampling frame of each park.
   - Provide quantitative information about the distribution and composition of landbird assemblages within 3 years.
   - Determine long-term trends of species richness, relative abundance, and density for abundant breeding landbirds at year 15 and for every subsequent 3 year period.
   - Provide long-term trends in similarity of landbird assemblages within the sampling frame at each park by year 15 and for every subsequent 3 year period.

2. Co-sample habitat parameters and integrate bird and vegetation monitoring to aid in interpretation of landbird status and trends.
   - Co-sample habitat parameters every 3 years to provide information about potential causes of landbird trends.
   - Integrate landbird and vegetation monitoring data to aid in the development of the KLMN Comprehensive Synthesis Report.

SOP #17: Data Analysis and Reporting (continued).

3. Determine status and trends in demographic parameters (productivity, adult survival, and recruitment) for selected landbird species at a mixed-conifer and riparian habitat at ORCA.
   - Determine the breeding status of landbirds annually.
   - Determine long-term trends of relative abundance, productivity, survival, recruitment, and fitness in abundant breeding landbirds.

In consultation with scientific staff in the KLMN parks, we have developed a schedule for analysis and reporting that addresses these objectives over the first 15 years of the program (Table 1).

Table 1. Overview of general reporting tools with purpose/objectives and reporting year.

Report	Year	Purpose/Objective: 1. Monitor breeding landbird richness and density	2. Co-sample habitat parameters	3. Using mist netting, determine status and trends in demographic information	4. Provide quantitative information about landbird assemblages
Annual Report	All sampling years	Provide description of each field season's efforts and key findings			
Analysis and Synthesis Report 1 Detectability Density Community structure	2010	X	X		X
Analysis and Synthesis Report 2 Analysis of status and trends of mist netting data at Oregon Caves	2013			X	
Analysis and Synthesis Report 3 Power analysis of point count data	2016	Provide information about statistical power of monitoring sampling design (point count data).			
Analysis and Synthesis Report 4 Topic to be determined	2019				
Analysis and Synthesis Report 5 Analysis of status and trends for all parks (point count data)	2022	X	X	X	X

Annual Report

The Annual Report will provide a summary of monitoring efforts for the year, due on March 1st of each year following a field season. The Annual Report will include:
(A) An executive summary;
(B) An introduction referencing the protocol;
(C) A summary of the current year's monitoring efforts including the number of VCP point count surveys conducted per transect for each park and the number of net hours, captures, and area search surveys by constant effort monitoring effort;
(D) A summary of past efforts;
(E) A summary of bird detections and associated Partners in Flight status;

(F) A list of additional birds detected only on species checklists;
(G) Public interest highlights;
(H) A summary of relevant outreach, reports, publications, and presentations; and
(J) Documentation of any changes made to the protocol.

In addition to the Klamath Network specific annual report, each year the Klamath Bird Observatory (KBO) completes comprehensive reports that summarize their bird monitoring efforts throughout the Klamath region. These reports provide regional bird monitoring cooperators with a picture of how discrete monitoring efforts and specific programs (e.g., the KLMN landbird monitoring effort) fit within the larger Klamath Bird Monitoring Network. KLMN landbird monitoring efforts will be integrated into these regional reports.

Analysis and Synthesis Reports

Analysis and Synthesis reports will be completed every third year, due on April 1st of the following year (e.g., final draft of 2010 Analysis and Synthesis report will be due April 1, 2011). We have collaborated with park staff to identify the scope of each analysis report and to articulate specific questions to be addressed by each report. In general, analyses of data collected through implementation of this Landbird Monitoring Protocol will provide information about bird-habitat relationships, population trends from point count and area search data, and trends in abundance and demographic indices derived from mist netting data. Analyses of single species will be focused on common species and conservation focal species in the Klamath region as identified by Partners in Flight (PIF) (Altman 1999, 2000; CalPIF 2002a, 2002b, 2004, 2005; RHJV 2004); community analyses will be inclusive of all species.

Analysis and Synthesis Report 1: Determining Status and Bird Community Structure

The first Analysis and Synthesis report, prepared in 2010, will focus on 3 years of data collected at the VCP point count stations during the 2008-2010 field seasons. The report will contain two related analyses that will inform us about the nature of bird communities in the parks of the Klamath Network, as well as the feasibility and efficiency of our sampling regime. The first analysis will explore *detectability* and spatial patterns of *species density* and the second will examine the *community structure* of our avifauna.

Detectability and Density Analysis

Bird species vary in detectability for a number of reasons related to differences in vocalization, visibility, and other behaviors. Moreover, the detectability of the same species varies from place to place because of differences in habitat structure (e.g., a bird species may be harder to detect in dense chaparral than in grassland). Although individuals are trained together, detection rates can also vary by surveyor. We will conduct an analysis of factors influencing the detectability of common species and PIF focal species in the five parks where extensive surveys will be conducted. We will develop detection functions to be used for estimating density of birds from raw counts. We will use the most recently available version of the free software program *Distance* (Thomas et al. 2006), following procedures outlined by Buckland et al. (2001), which are similar to those outlined by Seigel et al. (2007).

Distance sampling data will be used to model a detection function. An understanding of the rate at which detection probability declines with distance from the observer allows for a better grasp of other factors that affect detectability (e.g., environment, observer, cue, and cluster). Data analysis will begin with visual evaluation of histograms that compare frequency and detection function with distance. Such histograms can highlight anomalies caused by outliers, evasive movement, or other factors. After such initial graphical analyses, we will fit competing models to the data (Buckland et al. 2001). First, we will select a key detection function by testing the uniform or half-normal function to start, then the hazard rate function. Next, we will select a series expander (cosine, simple polynomials, Hermite polynomials) if needed. Then, resulting models will be selected using Akaike's Information Criteria (AIC) (Burnham and Anderson 1998). Using distance to account for detection probability, annual density estimates for each species analyzed (by point, route, and park) will be generated, along with 95% confidence intervals.

Spatial Patterns of Species Density

To consider spatial patterns of species density within the parks, density estimates at the point scale will be analyzed with vegetation composition and structure variables collected at each point to determine the relationship of species density and specific habitat features. We will examine a correlation matrix to determine highly correlated variables (>60%) (Morrison et al. 1987). The most biologically significant of correlated variables will be retained in further analysis. We will then use principal components analysis to select a set of significant predictor variables. A set of general linear models (Crawley 1997, Seavy et al. 2005) that use these predictor variables to describe species density estimates by point will then be compared using AIC to determine which habitat features, and combination of habitat features, make up the best fitting models. This aspect of the analysis will be conducted in R Project for Statistical Computing (R Development Core Team 2008).

Analysis of Landbird Community Structure

A quantitative understanding of the species composition of landbird assemblages in space, and in relation to known environmental gradients, will provide context for interpreting all subsequent monitoring results. Delineation of recurring groups of birds will also be of interest to determine if habitat associations are clearly defined or if birds sort individualistically across the park landscapes. These analyses will also allow us to evaluate which uncommon birds tend to occur with the more common birds that may provide inference for status and trends.

Bird assemblages will be analyzed for each sampling frame using standardized ordination and classification techniques (Gauch 1982, McCune and Grace 2002) and related to variation in environmental variables such a elevation, vegetation cover, and aspect. Nonmetric Multidimensional Scaling (NMS) will be used to ordinate the routes using the species presence/absence data (McCune and Mefford 1999). Ecological distances in similarities in bird community composition will be displayed using the Sorenson distance metric. Monte Carlo tests will be used to determine whether the axes generated by NMS were stronger than those obtained by chance. To determine if variation in bird community composition is associated with independent variables, we will perform indirect gradient analysis by determining Pearson's correlations between the variables and each ordination axis. These correlations will be plotted on the ordination bi-plot diagrams with arrows representing the direction and strength of the correlations (McCune and Mefford 1999).

We will use hierarchical clustering analyses (McGarigal et al. 2000) to evaluate the presence and significance of assemblages in the bird data. Delineation of these assemblages will allow us to evaluate the linkages between groups of birds and habitat features. Hierarchical cluster analyses will be performed with the Cluster Analysis option in PC-Ord using the Flexible beta linkage mechanism (with beta set at -0.25) and the relative Euclidean distance measure (McCune and Grace 2002).

Analysis and Synthesis Report 2: Population Trend Analysis of Banding Data

In year six, the analysis report will focus on 10 years of data collected between 2002 and 2012 at the Oregon Caves constant effort monitoring station. We will conduct trend analyses of relative abundance for both breeding and migrating species. We will compare and contrast these results with other trend information generated from Klamath Bird Monitoring Network and Breeding Bird Survey data. Productivity indices generated from the Oregon Caves data will be included as a covariate in the trend models to evaluate the relationships between breeding success, population abundance, and the condition of breeding birds.

For these analyses, we will compare annual capture rates of hatch year (juveniles) and after hatch year (adults) birds, to estimate trends of breeding and migratory populations. Age-specific annual capture rates will be calculated by season and when appropriate adjusted for missed banding effort using methods developed by the Institute for Bird Populations (Nott and DeSante 2002). In addition, the banding data will be analyzed to estimate annual indices associated with the condition of breeding individuals (e.g, breeding status as indicated by brood patch and cloacal protuberance scores, body condition, and indices relating to variation in breeding adult age structure).

Breeding Adult Metrics

Breeding metrics will be derived using a variety of after hatch year captures. We assume the majority of adult birds captured during the breeding season nest somewhere in the immediate vicinity of the station. Several authors have defined a breeding season using various approaches and considered birds captured within that time period as a measure of the breeding population (Benson and Winker 2005, Lloyd-Evans and Atwood 2004, Ballard et al. 2003, Ralph and Hollinger 2003, Dunn and Hussell 1995). Additionally, we will work with the Institute for Bird Populations to develop techniques that consider annual variation in body condition and age structures to help qualify annual measures of abundance (P. Nott, personal communication, November 3, 2009).

We will create the following breeding metrics using breeding season adult captures:

1. **Brood Patch Defined** - female captures with a brood patch scored as “vascular” or “wrinkled.” Counts of female birds in the height of breeding condition are the most conservative representation of the breeding population and are therefore the most certain index for local breeding populations. By limiting counts to breeding females, this index avoids bias by eliminating non-breeding females and unpaired males. Although birds captured with brood patches scored as “smooth” and “feathers growing” might legitimately be locally breeding females, the potential to erroneously score a hatching year bird with a “baby belly” or other molting individuals justifies conservatism. Species where males share incubation or brooding activities are excluded.

2. **Breeding Defined** - captures evaluated as either having a well developed brood patch (females) or enlarged cloacal protuberance (males).
3. **Breeding Resident** - birds captured and determined to be in breeding condition (well developed brood patch or enlarged cloacal protuberance) or recaptured greater than 6 days from original capture (including individuals captured across years).
4. **Breeding Window** - the beginning of the breeding window is the first 10 day period where the cumulative number of birds captured in breeding condition exceeds 5% of the cumulative capture rate. The close of the breeding window is the 10 day period where the cumulative capture rate of birds in breeding condition reaches 95% of all birds captured in breeding condition.
5. **Timing of Breeding** – first, second, and third day of HY capture.
6. **Body Condition** - weight to wing chord ratios.
7. **Seniority Indices** - based on position of age-specific wing chord as it relates to variation is size between second-year and after-second year, as estimated using a proportion of the individuals precisely aged.

These last three indices represent measures of fitness. For example, measures of productivity can be associated with migrants that arrive early and in good condition (Nott et al. 2002).

Productivity Metrics

Indices of reproductive success (HY:AHY) will be calculated as the ratio of effort adjusted HY individuals to AHY individuals (unique band numbers, not captures). To consider annual trends in productivity, we will derive a metric by dividing the number of hatch year birds captured by the various breeding adult counts described above. We will create up to two alternative counts that represent locally hatched birds:

1. **Hatch Year Juvenal Plumage** - all hatch year birds captured with greater than 50% juvenal plumage.
2. **Local Residents** - all hatch year birds captured at least once with greater than 50% juvenal plumage or recaptured greater than 6 days from original capture.

Migration Metrics

During fall migration, birds that likely breed throughout a larger geographic scale are captured, as compared to those captured during the breeding window, captured in breeding status, or captured in juvenal plumage. To represent these populations, we will create up to three post-breeding season metrics:

1. **After Hatch Year Fall Migration Window** - all after hatch year birds captured after the close of the breeding window (defined above).
2. **Hatch Year Fall Migration Window** - all hatch year birds captured after the close of the breeding window (defined above). This is an arbitrary starting point for counting hatch year birds, but we chose this comparable metric for comparisons with the After Hatch Year Fall Migration Window captures.
3. **Hatch Year Dispersers** - all hatch year captures during the entire season that were not captured at any time with greater than 50% juvenal plumage and were not recaptured at any time.

Population Dynamic Models

Using the breeding adult and migration metrics for the top 10 species captured at Oregon Caves, we will estimate trends. Instead of employing nonparametric statistics or data transformations, we will use generalized linear models (GLMs [Crawley 1997, Seavy et al. 2005]) that allow for non-normal random components and accommodate the distributional properties of count data. To estimate trends in captures, we will fit GLMs specifying a Poisson distribution and log-link, where the annual capture total for each species will be the response variable and year the explanatory variable. We will test to assure the data fit a Poison distribution. If they deviate, we will test other distributions for goodness of fit, such as Gaussian or negative binomial, which can perform better when distribution of count data deviate from Poison distribution (White and Bennetts 1996). The year parameter is a measure of the magnitude of the population trend. To estimate the influence of annual productivity on population trends, we will use the previous year's hatch year abundance as an additional explanatory variable of population size. By incorporating this measure in the trend model, we can assess the association between productivity and population abundance.

Analysis and Synthesis Report 3: Power Analysis of Point Count Data

Report three will focus on evaluating the power to detect a 50% decline in density and/or abundance over 20 years with a fixed sample size and significance level of 0.10. While a power analysis was completed to help design this protocol, the purpose of this report is to redo the power analysis using data collected following this protocol to 1) ensure the methods being used support the conclusions of the prior power analysis that was completed using what was assumed to be similar data, and 2) to determine which species we will have sufficient data on to provide trend estimates that will be developed in the fifth Analysis and Synthesis report, and 3) to determine the statistical model for trend that will be used for the trend analysis in report five. We will use a simulation approach implemented in R or SAS to evaluate power. In this report, we can address several questions, not just the observed power for the specified sampling design and sampling objectives. For example, how many routes and how many years of data are required to detect a 50% decline with power =0.80 and $\alpha = 0.10$?

We are interested in estimating trends in park-wide density and/or relative abundance for the most abundantly detected migratory and breeding species. For the rare species, we will explore using occupancy models to estimate trend (MacKenzie et al. 2006). Density is estimated using the DISTANCE package, which accounts for differences in detectability. Relative abundance is the number of birds counted per route.

We will explore two different types of mixed models for modeling trend in relative abundance and density: linear mixed models and generalized linear mixed models (GLMM). It is possible that density will adhere to the assumption of Gaussian errors; thus, a linear mixed model will be sufficient. However, relative abundance, essentially a count, may be better modeled using a Poisson error structure. For example, Purcell et al. (2005) used an overdispersed Poisson distribution for bird point count data. The overdispersion parameter allows for extra variability common in ecological data; the route-to-route variability and observer-to-observer variability are accounted for by random effects. Another modeling approach used by Sims et al. (2006) modeled bird counts using a linear mixed model with log transformed counts. Their model also accounted for route-to-route variation via a random effect, but they furthermore accounted for year-to-year variation common to all plots (this would be confounded with observer-to-observer variability) and year-to-year variation specific to each plot that could be due to habitat or other local differences. Either approach may be suitable to model trend after 3 years of data have been collected within each park. The precision of the variance component (random effect) estimates will improve with more years of data. However, report three will explore which approach is best suited for the KLMN. The GLIMMIX procedure in SAS, or a similar package in R, will be used to fit linear and generalized linear mixed models to the monitoring data.

The Sierra Nevada Network lakes protocol has developed R scripts to simulate power for a linear mixed model (Heard et al. 2008). Their methods utilize those developed by VanLeeuwen et al. (1996), Urquhart and Kincaid (1999), and Piepho and Ogutu (2002) for analyzing trends in wildlife populations. They use a log transformation similar to the work by Sims et al. (2006); we will explore using their approach directly or adapt their approach in the generalized linear model framework. Their substantial efforts will inform our work and should help to expedite our development of usable R scripts.

Subsequent third year analysis reports will relate to the objectives outlined in the KLMN Landbird Monitoring Protocol. Analyses will include investigation of trends in species richness, habitat relationships, survivorship, and breeding phenology.

Analysis and Synthesis Report 4: to be Determined

After discussions with park staff, we determined that by 2019 there would not be enough data gathered at each park to determine trends in bird species using the VCP point count data (report five). We also recognized that park staff priorities and concerns may change over time. Since this report will be due 11 years after implementing the Landbird Protocol, we have decided not to designate what report and associated analysis will be completed for report four. Within one year of the 2019 field season, we will work with park staff, local avian experts, and statisticians to determine which report and associated analysis would be most valuable at this time based on the data we have collected. The constants to keep in mind when designated the topics of the report are that the report should relate back to the objectives of this protocol, be useful to park managers, and that the analysis should be feasible based on funding and available knowledge.

Analysis and Synthesis Report 5: Analysis of Status and Trends for all Parks (Point Count Data)

Status and Trends in PIF Focal Species Abundance

In year 15, we expect to have a sufficient time series to begin the detection of trends in densities for some of the species that have low year-to-year variability. The power analysis (report three) will inform us as to which species we will be able to detect a trend at year 15. Once complete, this trend analysis will be repeated periodically in future years to continue to monitor trends in both common and less common species. The timeframe for repeating the trend analysis will be determined in the third Analysis and Synthesis report. For trend analysis, we will use the modeling approaches described above for report three. In particular, linear mixed models or generalized linear mixed models (GLMM) will be used. The GLIMMIX procedure in SAS, or a similar package in R, will be used to fit linear and generalized linear mixed models to the monitoring data. Some adjustments to the models used in report three may be needed due to the longer time series of data, such as in the correlation structure.

For trend analysis of density data, the focus is on detecting a nonzero slope coefficient, assuming a fixed linear effect of time in a mixed or generalized mixed model (VanLeeuwen et al. 1996; Piepho and Ogutu 2002). Once the null hypothesis of no linear effect of time is rejected, we will explore the nature of change over time. For example, does the change through time appear cyclical or is it quadratic? Once enough data are available, these higher order terms can be included in the model.

Geostatistical Analysis and Modeling

Kriging: Kriging is a statistical interpretation method that uses data from a single data type (parameter) to predict values of that data type at unsampled locations by examining the spatial autocorrelation between sites (Beers and Kleijnen 2003, Krivoruchko 2006). Using Kriging methodologies, we will incorporate detection probabilities and estimated abundance as parameters into several models and associated maps that will illustrate the areas of a park where PIF focal species are (1) most likely to be detected, (2) most abundant in any given year, and (3) changing in abundance over time. Ordinary Kriging, based on estimated abundance (described below) of PIF focal species, will be used to develop spatial models for each year a park is surveyed. When complete, this modeling effort will result in five maps that demonstrate the predicated abundance of individual species across the park at a given sampling period. Once abundance maps have been developed, we will conduct a change detection analysis using these maps to determine if PIF focal species distributions are stable or shifting in space over time. In addition, ordinary Kriging will be used to develop models that incorporate detection probabilities (described below) over the 15 year sampling frame. Spatial models based on detection probabilities will be used to develop a map that predicts the probability of observing a species in a given location at a park.

To complete the geostatistical analyses, we will utilize the latest software (currently ArcGIS, ArcGIS Geostatistical Analyst, and ArcGIS Spatial Analyst) to develop the models and associated maps. Prior to developing the maps, model assumptions and trends will be examined using variograms, histograms, and QQplots. Based on initial exploration of the data, detrending and transformations should be applied when necessary (Johnston et al. 2001, Beers and Kleijnen 2003) to ensure that data are in appropriate form for the models used.

Estimating Abundance: We will use the methods described above for report one, *Detectability and Density Analysis*, to develop estimates of abundance for PIF focal species. Abundance estimates will be calculated at each route for each year and models using ordinary Kriging and the change detection methods described above will be used to examine the change in abundance of PIF focal species over space and time.

Developing species occupancy models: We will combine the data collected at the 12 point count stations along each route to determine the occupancy status of a species at a given route in a given year. The occupancy data will be examined over the 15 year time frame to develop several single species multiple season models (MacKenzie et al. 2006) that incorporate local extinction and colonization to predict detection probabilities when detection probabilities are less than one for each site (MacKenzie et al. 2003). Based on the results of the analysis of habitat data described in earlier sections of this SOP (*Detectability and Density Analysis*), we will examine occupancy models that incorporate statistically and biologically significant habitat variables for each species as covariates. Models will be ranked based on AIC (Burnham and Anderson 1998) and the model weights and standard errors will be used to estimate the contribution of the covariates to the model (Mackenzie et al. 2002). This will be accomplished using the most up-to-date version of the software PRESENCE (currently v2.1) to analyze the data. Once detection probabilities have been established for each site, we will use ordinary Kriging to model the detection probability of each PIF focal species within the park, as described above.

Determining Changes in Species Composition

Changes in species composition over time can provide a particularly valuable adjunct to population trends information. The entire assemblage of species not only provides a more robust indicator of environmental change than individual species, but major changes in the relative frequency or abundance of species can also provide important information to help evaluate changes in the abundance of PIF focal species. One of the most fundamental types of detectable change in multivariate or multispecies datasets is directional change in dissimilarity (i.e., the decline in shared species) at a site over repeated visits, or “progressive change” (Philippi et al. 1998) in communities over time. Comparisons of dissimilarity among sites over time can illustrate stability (no change) or instability. Unstable patterns include directional changes in species composition over time as dissimilarity increases or convergence over time as it decreases (Collins et al. 2000; Figure 1). Directional change is the most likely outcome for long-term monitoring of ecological change in bird communities in response to environmental change (e.g., climate change). Convergence could also present a management concern if it indicates a relative increase in generalists and a decline in the rarer bird species at a sample site over time. If dissimilarity among samples is constant over various time intervals, the system is compositionally stable. If dissimilarity increases over time, the system is changing. If dissimilarity decreases over time, the system is unstable and undergoing convergence.

To evaluate progressive change in composition of our monitoring sites over time, we will develop time-dependent dissimilarity indices to compare landbird composition at each site over the five sample intervals. Dissimilarity indices will be calculated between a site at the first sampling event (time one; t1) and each of the next four sampling events (t2-t5). Our dissimilarity index, D, will be created from presence-absence data as the complement of the widely-used Jaccard’s Index of Similarity (Legendre and Legendre 1983).

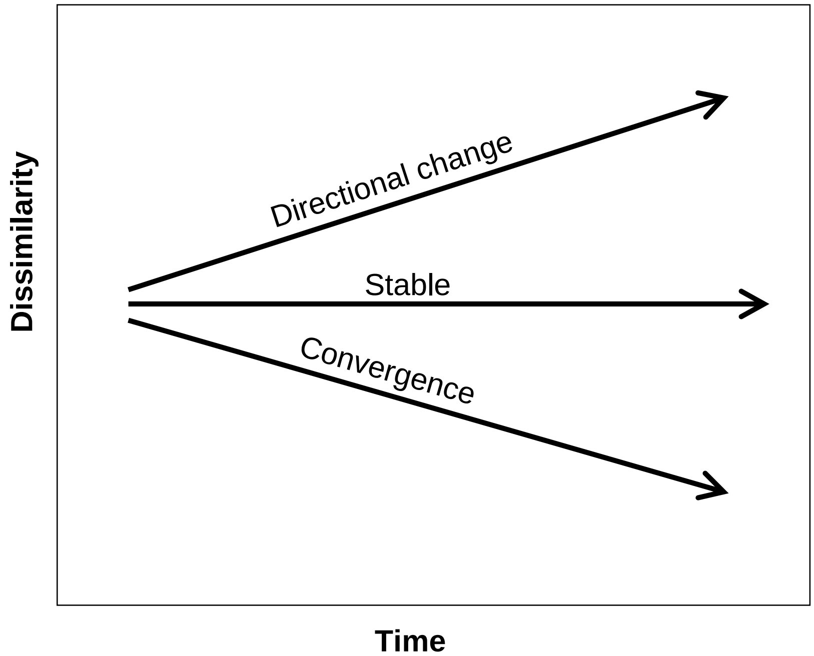

Figure 1. Three patterns of dissimilarity as a function of time with time series data (after Collins et al. 2000).

Jaccard's Index can be calculated as follows:

$$J = a/(a+b+c)$$

Where the number of species present in both samples is a, the number of species present in sample 1 but missing from sample 2 is b, the number of species missing in sample 1 but present in sample 2 is c.

And the dissimilarity index D is the remainder after subtracting J from unity:

$$D = 1 - J.$$

This metric is well understood, easily calculated, and available in most standard multivariate statistical packages (Community Analysis Program, PC-Ord). Once a dissimilarity matrix is prepared that compares sampling event 1 with all subsequent sampling events, the null hypothesis of a zero slope in pairwise dissimilarity over time can be evaluated with general linear models for each sample site in the park. Although 25-35 analyses will be needed per park, these analyses should proceed quickly. In the event of determination of a significant, positive nonzero slope for a site, the standardized coefficient of the regression model should be recorded. Because there will be multiple comparisons (25-35 sites) per park, we will need to subject the findings to a suitable post hoc test for multiple comparisons, such as Tukey's test (Tukey 1953). A significant change will be reported only with determination of a significant result from the post hoc test.

If a significant change is detected, we will analyze the spatial pattern in the results by analyzing spatial autocorrelation patterns in the significant slope patterns detected. Within a GIS program, Kriging will be used to determine spatial patterns in change across the park in question. For example, it is quite possible that different areas of the parks will show different degrees of compositional similarity or be changing at different rates. In such analyses, nonsignificant or negative linear models of dissimilarity over time will standardize to zero for a sampling site, with standardized slope coefficients for the significant site models presented.

In summary, the results to be reported from multi species analyses in this Analysis and Synthesis report will be: (1) the detection of significant positive evidence of environmental change at each of the sampling locations in the park, as indicated by significantly positive slopes in linear models of compositional distance over time; (2) a report of significant levels of change across the park sampling frame as verified by Tukey's test of multiple comparisons; and (3) a summary of the spatial patterns in compositional change within the park, as indexed by spatial Kriging models of the linear model slopes across the park sampling frame.

Report Format

Annual Reports and alternate year analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. These templates and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

Procedures for Reporting

1. The Annual Report will be completed in a totally digital format. The Annual Report will be published as a *Data Report* for the park and therefore should follow the standard, accepted format for a regional report. If the report has pages generated as Microsoft Access reports, the report should be run in Access and **saved with a .snp file extension**.

2. Files should follow the naming structure outlined in the Klamath Network File_Naming_Convention_Guidelines. Standards all file names should follow include:

    a. File name will be no less than 10 characters in length.
    b. File names must never contain special characters (*&@%$) or spaces. When separating names, use an underscore (e.g., use_underscore).
    c. Dates will be in one of the following formats YYYYMMDD, YYYYMM, or YYYY. The most detailed date information should be used whenever possible.
    d. The date should correspond to the date the document or version of the document was created. Dates should be the last component in the naming convention.
    e. The title should be the first portion of the file name, be in mixed case format, and be as descriptive as possible (e.g., Landbird_Annual_Report_20070401).

3. Collate document together, with appendices (use of templates posted on the NRPM web site is highly recommended), and submit draft manuscript and the NRPM Manuscript Submittal Form and Checklist via email to one of the NPS Key Officials listed on the NRPM web site.

4. The NPS Key Official determines whether or not additional peer review is necessary based on the manuscript content and the quality of the initial reviews, and if deemed appropriate, arranges for and oversees additional peer review. The NPS Key Official

determines whether or not a Management Review is necessary. If so, he or she selects an appropriate reviewer who can verify consistency with NPS policy or clear an appropriate relation to NPS policy and that appropriate treatment is given to sensitive issues.

5. Once the Key Official is satisfied that reviewer comments have been adequately incorporated and the report meets the minimum standards for the series, the report is approved for publication in one of the series and the contributor obtains a report number, as well as a NPS Technical Information Center (TIC) identification number, following the guidance on the NRPM web site.

6. Once the report numbers are added, produce a PDF (portable document format) version of the publication and send it to the Klamath Network contact. In addition, submit the PDF and all documents used to create the PDF (.xls, .doc, .snp) to the Klamath Network Data Manager.

7. The Klamath Network Data Manager will be responsible for archiving and distributing the document following processes outlined in the KLMN Data Management Plan. Annual reports will be sent to the Resource Chiefs of each park, loaded to the NPS Data Store, and posted on the KLMN Internet and Intranet web sites. A record for the report will be created in NatureBib. Species listed in the annual report will be compared to park species lists in NPSpecies to ensure all species are included on the list. Discrepancies between species mentioned in the report but not on the park species list will be discussed between project researchers, park staff, and the Klamath Network, with adjustments made as necessary.

Literature Cited

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